MILTON'S IDEAS OF SCIENCE AS SHOWN IN "PARADISE LOST"

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EGGLESTON'S "Transit of Civilization" starts with an interesting discussion of popular belief in Europe in the seventeenth century. In its literature we find much about astronomy and astrology; especially did they touch the popular imagination. Astronomy must have been a jumble of the Ptolemaic "firm-set earth" and the Copernician theory of the revolution of the spheres. Lowell speaks of Copernicanism as "the theory that has so stirred all our modern wits." It seemed to the suspicious thought of the time to smack of witchcraft; Galileo was imprisoned, Kepler was working in obscurity, and, as we read, occasionally casting horoscopes for princes. "In the best society, the sun, moon and stars continued to revolve around the earth" without gravity and with prognostics dire of diseases and divers fortunes. Astrology was a serious avocation. Comets, eclipses, and meteors were danger signals. "God governed this one little world, and logic was the only means of discovering truth." Finally the Copernican theory evolved constant proof of the correct standpoint; even the making of clocks received an impetus, and "almanacs gradually became filled with those minute calculations with which the world has since grown familiar."

At what point in this evolution of science Milton stood is indicated by the "Paradise Lost." It is probable that he was partly convinced of the truth of Copernicus's system; at least in two striking passages he shows his acquaintance with it.

One (Book IV., ll. 592–597) reveals the uncertain state of his opinion on the subject, where he states that the sun's setting in the west would be more easily explained if the earth revolved eastward. However, to be consistent with the general scheme of the poem Milton must make his "Prime Orb" roll incredibly fast to the west. Again (Book VIII., ll. 15–178), during Raphael's delightfully informal visit to the hospitable lovers, Adam discusses at length with the Archangel this debatable question of astronomy, the outcome of which discussion is later diluted for the understanding of submissive Eve. Adam per-

ceives how difficult it is to believe that the stupendous Universe revolves in one day about "this Earth, a spot . . . that better might with far less compass move." The Angel, however, is not only "affable" but discreet, as he responds that the truth is concealed by God from man and angels, and that speculations (evidently looking far down the ages) "move His laughter." As far as man's duty is concerned it is of no real consequence as to which moves. One feels here that Raphael (and Milton) inclined to the superior simplicity of the Copernican system, in spite of prudent conservatism.

The Ptolemaic theory was evidently more adapted to concentrating the emphasis of the poem on our little earth and its tragedy, whatever Milton's own scientific conclusions may have been. His was a profound mind; he had met Galileo and refers to him in Book I., l. 288, in Book III., ll. 588–590, and Book V., ll. 261 ff.; in his day the struggle between the two theories was waging; it is possible the poet was of one mind, the compact reasoner of another. His scheme in "Paradise Lost" is undoubtedly Ptolemaic. If one dare be expository in the presence of start dust and planetary whirls and the music of the spheres, the plan of the poem may be indicated somewhat thus:

Before time was, space, strangely enough, was in two divisions, the upper half Heaven, the lower Chaos—an inexpressible quagmire. At one day, however, in the annals of timeliness, a place was prepared for the outcast angels, below Chaos. We have now three divisions of "Universal Space." It was a nine-days' fall, or rather retrogression from Heaven, as angels are not subject to gravitation and had to be beaten through Space by Christ's thunders. That Space was as far as from the center of the earth "thrice to the utmost pole of the Universe" (Book VI., 1871); such is the effort of the human mind to express infinite ideas, for which there is no material language. During an ensuing nine days, while the rebel host lay overwhelmed upon the fiery lake in "restless ecstasy" of woe, Infinity is again modified (Book I., ll. 50–53). The new universe is created. Taking a pair of immeasurable compasses, "the Son" fixes their one foot far out in Chaos, and with the other describes a great circle in the void—the boundary of the new creation. Imagination rocks at the image! (Book VII., ll. 224–231). The new universe is attached to Heaven at its north pole, and at the place where an opening is left in Heaven for angelic communication. Who but a Milton would dare be thus exact in the face of infinity! Now for the Ptolemaic theory:

In this sphere the earth is the fixed center, hanging "self-balanced." Nearest earth were the seven planets including the sun and moon, Venus, and the "other wandering fires"—Mercury, Mars, Jupiter and Saturn. (These spheres according to Pythagoras and the most beautiful conception of poetic minds, moved "not without song," "each quiring to the young-eyed cherubim." Cf. also "Ode on the Nativity," stanza XII.)

Beyond the planets was the firmament, an eighth sphere, containing the "fixed stars." This was the sphere that turned from east to west in twenty-four hours, carrying with it "all the planets in their turn," which, however, had all separate motions of their own. There was also a ninth sphere, and finally a tenth, which was called the "Primum Mobile," an impenetrable shell separating the Universe from the turmoil of Chaos. In Book III., ll. 481–483, the ten spheres are enumerated, where the ambitious spirits attempt to ascend from Earth to Heaven, and are whirled aloft to the "Paradise of Fools" on the *outside* of the Primum Mobile.

This, in general, is the scheme that Milton has elaborated in his epic, first in the passage (Book II., ll. 561–565) where Satan, wandering on the dark outside shell of the universe, is attracted to the opening at the zenith, and through that beholds the whole interior; and again in the account of the creation in the magnificent Seventh Book.

The portion marked out by the golden compass from Chaos is impregnated with warmth and light and life by the Word of God. Noxious elements escape into Chaos from the lower part of the sphere. Then follows the "conglobing of like things to like" out of the "four grosser elements"—earth, air, fire, and water, as the ancient Greek philosophers considered them. Light, the fifth element, is evoked by the Creator. The sun, which Satan saw as the most splendid body in the universe, though but the fourth sphere, Milton describes as containing a large part of the light of the world, the Almighty having concentrated it there at the fiat, "Let there be light." (Book VII., ll. 359 ff.)

Milton's interpretation of the "firmament" is the reconciliation of the first chapter of Genesis with the Ptolemaic theory. The firmament separates the waters flowing around the Earth from water "diffused throughout the Universe." This He removed to the outside of the Eighth Sphere, forming the Ninth, or "Crystalline Sphere" separated from Chaos only by the Primum Mobile (Book III., ll. 444 ff.). Thus the firmament was the great extent of space between the earth and the utmost

boundaries of the eighth or visible sphere. This vast expanse was named heaven, after the greater Heaven, the abode of God. Line 176 in Book VII. ("Immediate are the acts of God") would seem to imply that Milton conceived of Creation as instantaneous, though perhaps for the sake of human limitations it is described as the work of six days.

Again in Book VIII., ll. 81 ff., occurs a very definite statement of the growth of the Ptolemaic universe by the addition of "orb after orb." Further on the poet refers to the two devices of the eccentric and the epicycle, by means of which complicated system of reasoning the Ptolemaic astronomers tried to explain why the sun's motion seems faster or slower according to the season (Book VII., ll. 82–84), in which connection it is interesting to note that Bacon himself showed his dissatisfaction with such reasoning in De Augmentis, IV., ll. 347–348, where he compares the contribution of astronomy to the human intellect to the fraud practised by Prometheus upon Jupiter.

We find Milton again wavering in Book VIII., ll. 130 ff., where the earth is said to have three motions; rotation on her axis, movement around the sun, and her "trepidation" (Book III., l. 483) during her orbit. Here is the Copernican theory; but in ll. 131 ff. Milton says, "which else" you must ascribe to the old theory that several spheres move contrary to one another with "thwart obliquities." As for the moon, it was supposed to have rain ("Her spots thou seest as clouds"), and perhaps inhabitants (Book III., ll. 145–147). "Other Suns, perhaps with their attendant moons," may be a reference to Galileo's discovery of the satellites of Jupiter and Saturn (*ib.*, ll. 148–149). It is interesting to note at the close of this passage on Milton's uncertain astronomical faith, how opposed are his to Bacon's pronouncements. Milton discourages the inductive process, "nor with perplexing thoughts to interrupt the sweet of life" (Book VIII., ll. 183–197). This is, of course, directly the opposite of all Bacon's teaching as to inquiry into the secrets of Nature with a view to solving her perplexities.

Finally in Book X. is an ingenious explanation, whether Ptolemaic or poetical, of the obliquity of the earth's axis to the ecliptic (ll. 671 ff.). "Some say" that after the Fall, God bade the angels turn the pole so that it no longer pointed toward Heaven's gate. Or else "the Sun was bid" to turn out of "the equinoctial road." At all events, Spring was thus prevented from "perpetual smile" on earth, and days and nights were made unequal.

Milton's astronomy has, I fear, been rather vaguely indi-

cated. It is, indeed, an unexampled combination of vagueness and exactitude, of material limitations and sublimity. It is less of earth than of Heaven and Hell and "Chaos and old Night." It is the conception of a soaring intellect and a blind man who sees flashing lights and geometrical shapes in the darkness.

As to his ideas of natural science, there is less to say. He held, like all his contemporaries, beliefs as to the physical influence of stars on beings of this earth. ("Their stellar virtue," etc., Book IV., l. 671.) "The sweet influences of the Pleiades" were supposed to bring gentle blessings when they were in the ascendant. In the autumn Orion brought storms "with fierce winds armed." "Comets shake pestilence and war" (Book II., l. 710). Astrology, I fancy, was a natural outgrowth of Ptolemaic astronomy. The most striking reference to astrology is in Book X., ll. 658 ff., where the "aspects" of planets is mentioned, which according to tradition were "happy and unhappy" as regards the destiny of man.

Quaint notions of chemistry occur. In Book I., ll. 673–674, Milton expresses the popular belief of the time as to the importance of sulphur. "In his womb was hid metallic ore, the work of sulphur." From Pliny to Bacon, men held that sulphur, mercury, and salt were the all-pervading substances in nature. Other minerals occur; "Naphtha an asphaltus" light the roof of Hell. Alchemy is also referred to in Book III., l. 601, and the "philosopher's stone." "They do bind volatile Hermes" evidently means the solidifying of fluid mercury.

All things need food, even angels and perfect men, "who fell upon their viands"; even elements, of which "the grosser feeds the purer"—Earth the sea, and Earth and Sea the air—they all need nutriment. The moon is fed by mud of the earth sucked up with the moisture, according to Pliny, who is here echoed by Milton: "The moon whence in her visage round, those spots, unpurged vapours," etc. "The sun receives his alimental recompense in humid exhalations, and at even, sups with the Ocean," a statement of which Landor strongly disapproved poetically. Another belief, expressed in Book X., ll. 243 ff., assumes that things "of like kind" have peculiar physical sympathy at whatever distances from each other they be—a sort of atomic telepathy. In Book X., l. 666, we find the old belief that thunder is rolled by winds.

In Milton's natural history, we are again reminded of Pliny, as where serpents "with snaky folds and added wings" are created (Book VII., l. 483). In Book IX., ll. 581–582 is an allusion to the supposed habits of serpents that loved the smell of

fennel and were said to suck ewes' udders. "The female bee," according to the belief of the day, is represented as the worker of the hive. The animals in "Paradise Lost" are all highly entertaining. Milton seems to have thought that brutes have a higher degree of intelligence than is usually attributed to them. "They reason not contemptibly," he writes in Book VIII., ll. 373–374. He alludes to the flight of cranes "with mutual wing easing their flight"—each helping the progress of the whole body by becoming in turn the point of the V. The will-o'-the-wisp he calls "a wandering fire" (Book IX., ll. 634 ff.). In accounting for this phenomenon Milton seems very modern, if we take its origin from "unctuous vapor" to mean gas from decaying swampy matter. Vultures are made to "scent a field unfought," as Beaumont and Fletcher also held in "The Beggar's Bush." This must have been a popular superstition. The different kinds of asps, scorpions, etc., in Book X., l. 524, seem to be taken direct from Pliny after the manner of natural historians of the day. Echoes are found here also of Lucan's "Pharsalia" (Book IX., l. 700).

The medical theories of Milton's day occur in various parts of "Paradise Lost," notably in that poignant passage of Book VII. on his own blindness, where he describes it as probably arising from "the drop serene" that left his eyes without blemish; yet he is not sure but that his case is one of "dim suffusion." Eye diseases were thought to arise from affections of "the humours." "Euphrasy and rue (Book XI., 1414) are mentioned as strengthening the eyes; euphrasy was called "eye-bright." The poet had possibly tried both in vain. In Book XI., ll. 477–493, occurs the famous enumeration of diseases—one sad result of Adam's fall. "Moon-struck madness" echoes another popular superstition. "In thy blood will reign a melancholy damp" is a reminder of Burton, who calls old-age "cold and dry" and of the "same quality as Melancholy." "Humours" and their baneful operations were prolific subjects for speculation in the sixteenth and seventeenth centuries, it appears.

Botany in "Paradise Lost" is interesting. What minute and loving memories of plants! Eve's troublesome vines make one think of the charming gardens described by Harrison and Sir Thomas Browne. But to one reader, at least, the most interesting observation, aside from Milton's amazing astronomy, is the detailed and accurate knowledge of geography displayed by the blind man. How minutely he remembered his maps! What marvelous surveys of geographical discoveries! What delight in sounding names! The passages are too well known to need

comment. One of the most remarkable, however, is in Book XI., ll. 385–411, where the eyes of the poet's mind glanced over all of the then known Asia, Africa, and Europe—a stupendous feat of memory, as well as an example of "the poetry of proper names." One is reminded of Macaulay's famous passage in his essay on Milton in which he describes the "long muster-roll" of "charmed names."

A striking impression that remains after a careful reading of "Paradise Lost" is the daring use Milton made of his immense knowledge—the combination of definiteness and mystery; titanic pagan angels fighting like the heroes on the plains of Thessaly, but in a definite Ptolemaic scheme; deathless beings, not subject to gravitation; Time in Heaven ("'Two days as we compute the days of Heaven' said the Almighty Father"); Satan suffering from the loss of his immortal ichor, as Mars did at the onslaught of Minerva, and modern methods of blood-stoppage applied; all of gorgeousness, awe, dignity, in a materialistic heaven with fighting angels who dig for metals to make cannon! How could any one at that time have accomplished such audacity with what are called Christian conceptions? Homer is audacious and sublime, but we call him frankly pagan. Again, in portions where exactitude of information is most evident, as in the "muster-roll of names," and in the Ptolemaic astronomy, occur some of the most transcendent passages of poetry!

The seventeenth century writers, it would seem, had an attitude of high romance toward science; at least they wrote about it poetically. (Wordsworth once said it must eventually become a subject for poetry.) Surely we find that poetic sweep of thought in Bacon with his visions of experimentation; in Burton who made a medical treatise read like a novel; in Sir Thomas Browne, whose observations on obscure researches sound like the Book of Revelation; and in John Milton, who marshaled all the hosts of his mighty mind to evolve a vision of creation out of darkness.